US005515018A

United States Patent [19]

DiMarco et al.

[11] **Patent Number: 5,515,018**

[45] **Date of Patent: May 7, 1996**

[54] **PIVOTING CIRCUIT BREAKER LOAD TERMINAL**

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[73] Assignee: **Siemens Energy & Automation, Inc.**, Alpharetta, Ga.

[21] Appl. No.: **348,018**

[22] Filed: **Dec. 1, 1994**

Related U.S. Application Data

[63] Continuation of Ser. No. 314,467, Sep. 28, 1994.

[51] **Int. Cl.**[6] **H01H 75/00**

[52] **U.S. Cl.** **335/16**; 335/172; 335/195; 218/22

[58] **Field of Search** ..... 335/16, 147, 195, 335/8–10, 167–176, 23–25; 200/147 R

[56] **References Cited**

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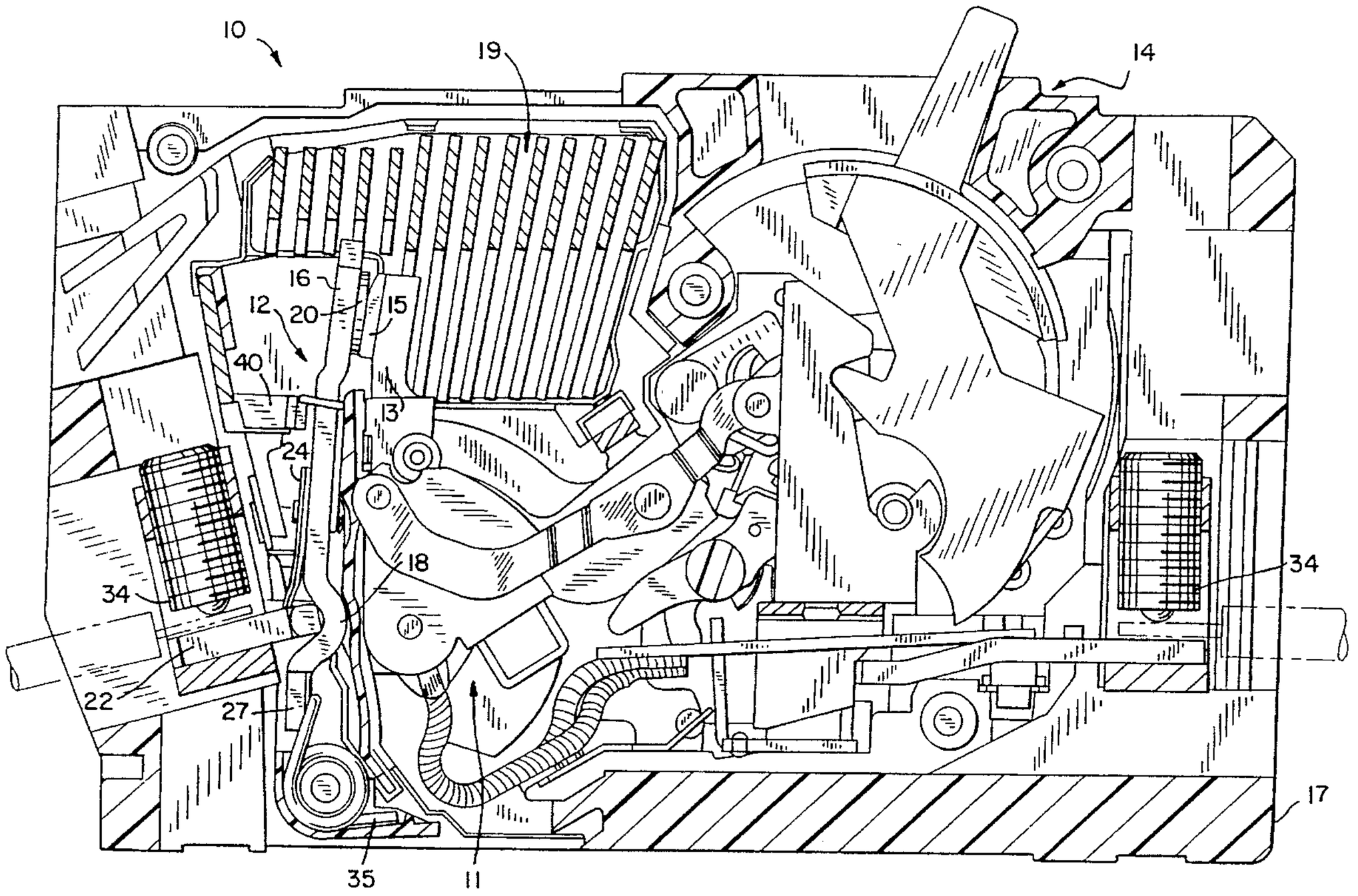
Primary Examiner—Lincoln Donovan

[57] **ABSTRACT**

An improved circuit breaker with moving line and load contacts is disclosed herein. The circuit breaker includes an enclosure for the operational components thereof including a line contact arm and associated contact for each phase of the circuit breaker, and an operating mechanism supported within the enclosure to move the contact arm(s) between open and closed positions. The circuit breaker also includes a terminal for each phase pivotally supported within the enclosure, and a load contact arm and associated contact for each phase pivotally connected to the terminal. The contact arms are supported so the contacts are engaged when the line contact arms are in the closed positions. The pivoted load terminal(s) allow the use of multiple connector types with the terminal(s), and the pivoting connection between the load contact arm and associated terminal facilitates a reduction in circuit breaker size for a given rating.

20 Claims, 4 Drawing Sheets



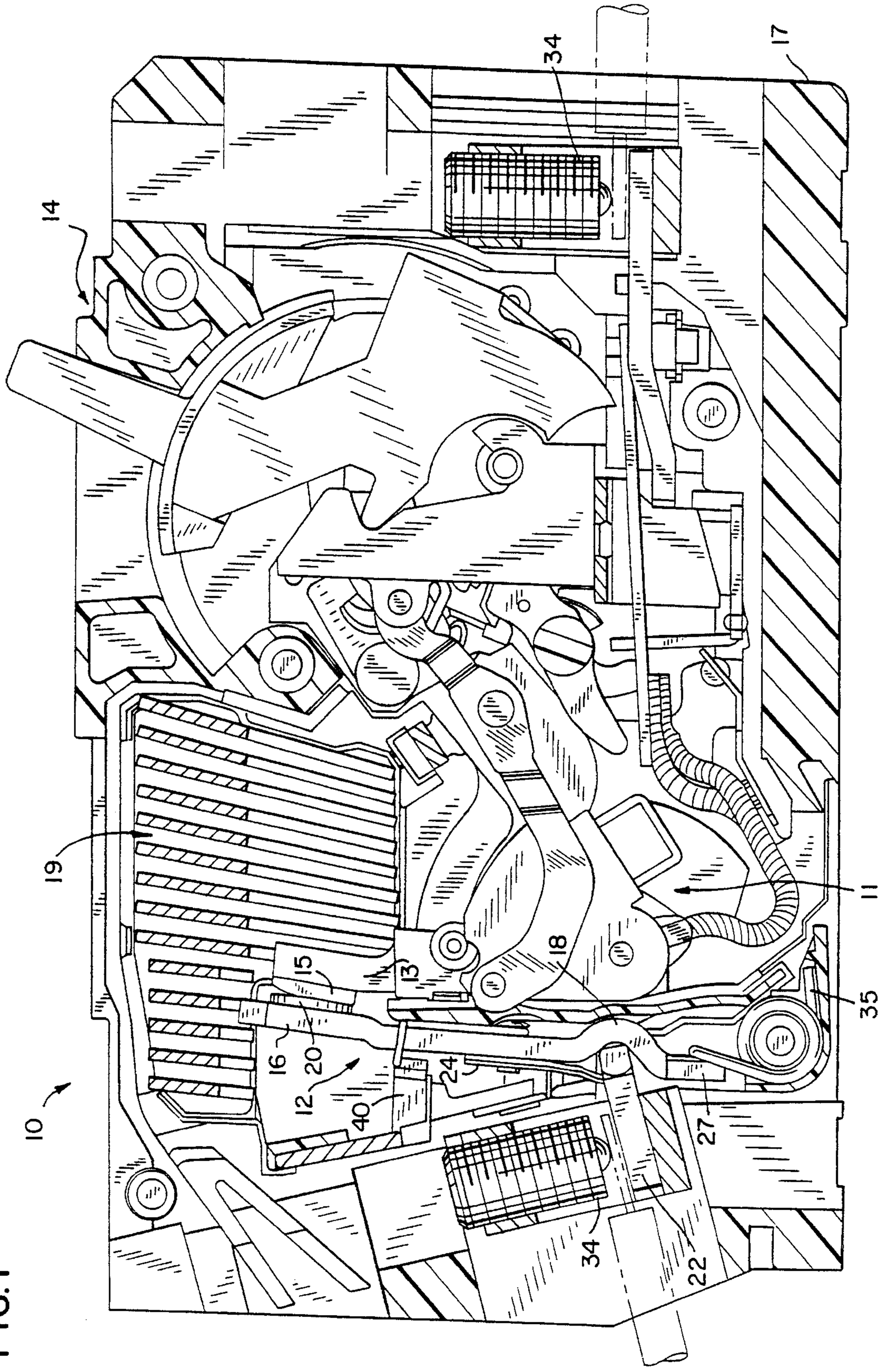


FIG. 1

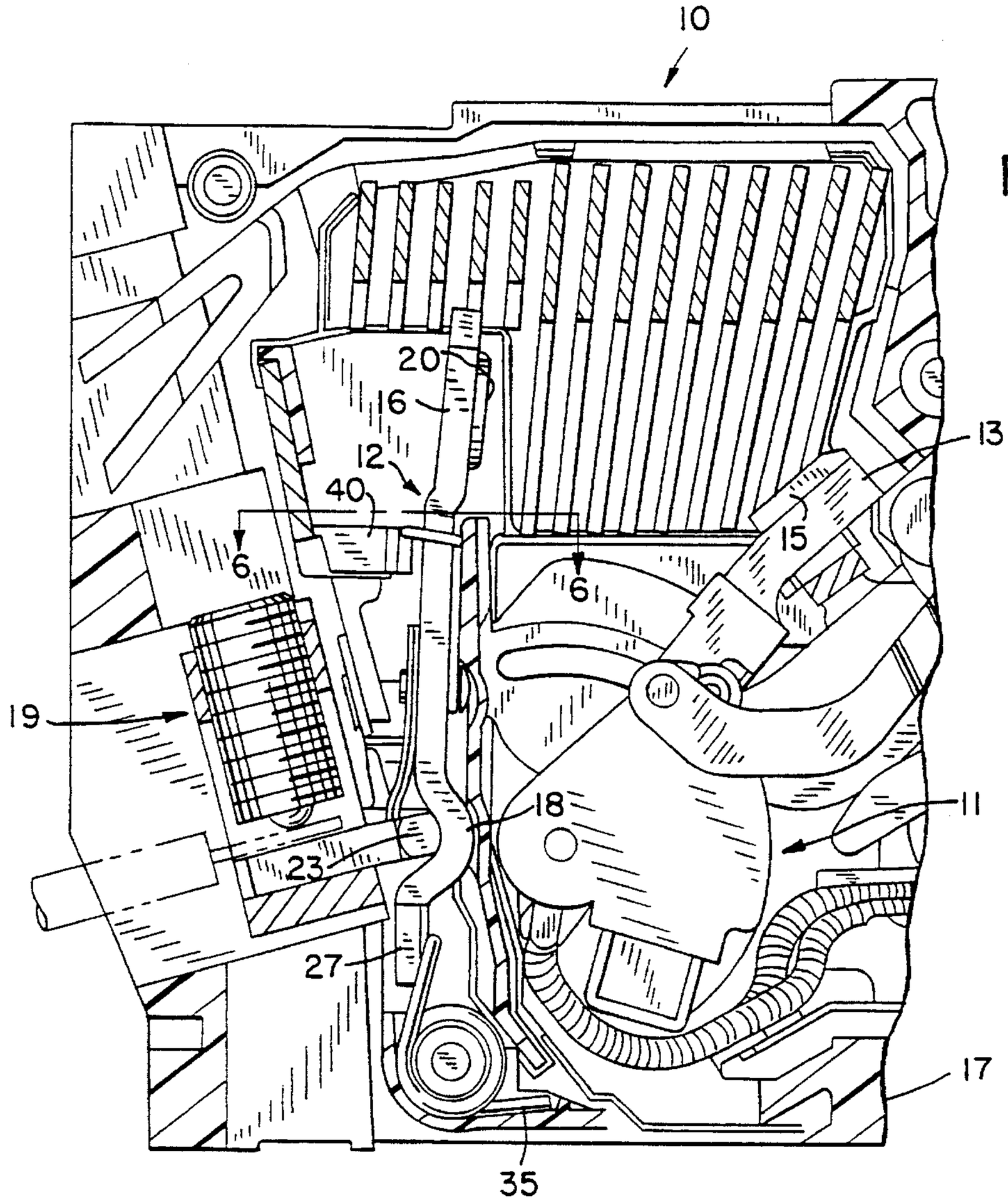


FIG. 2

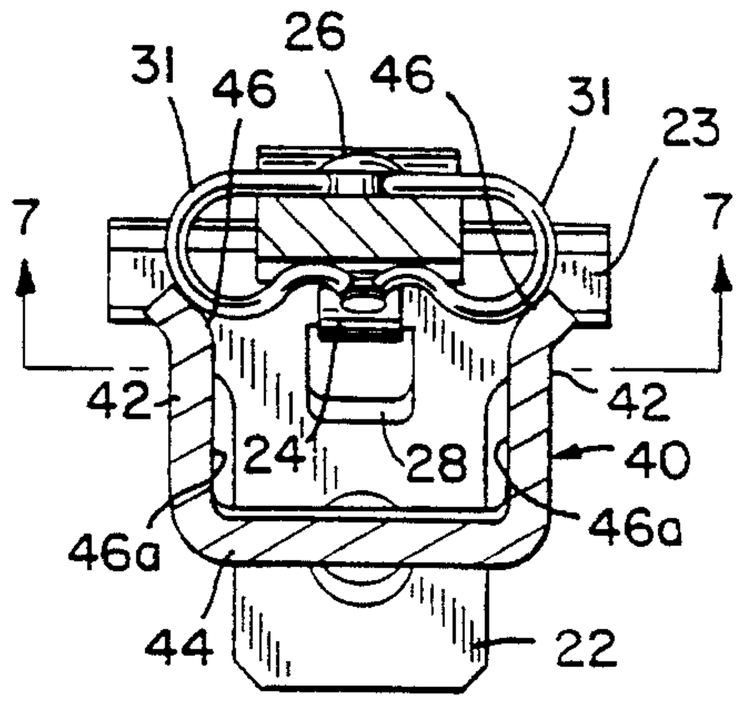


FIG. 6

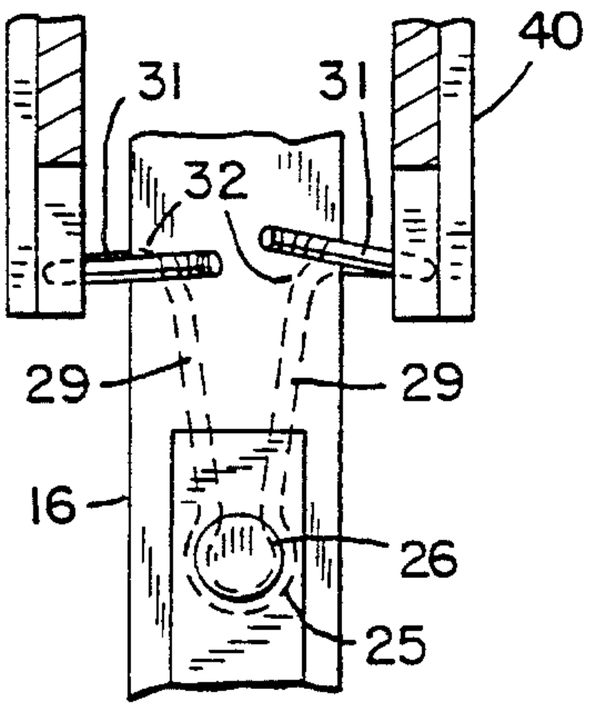
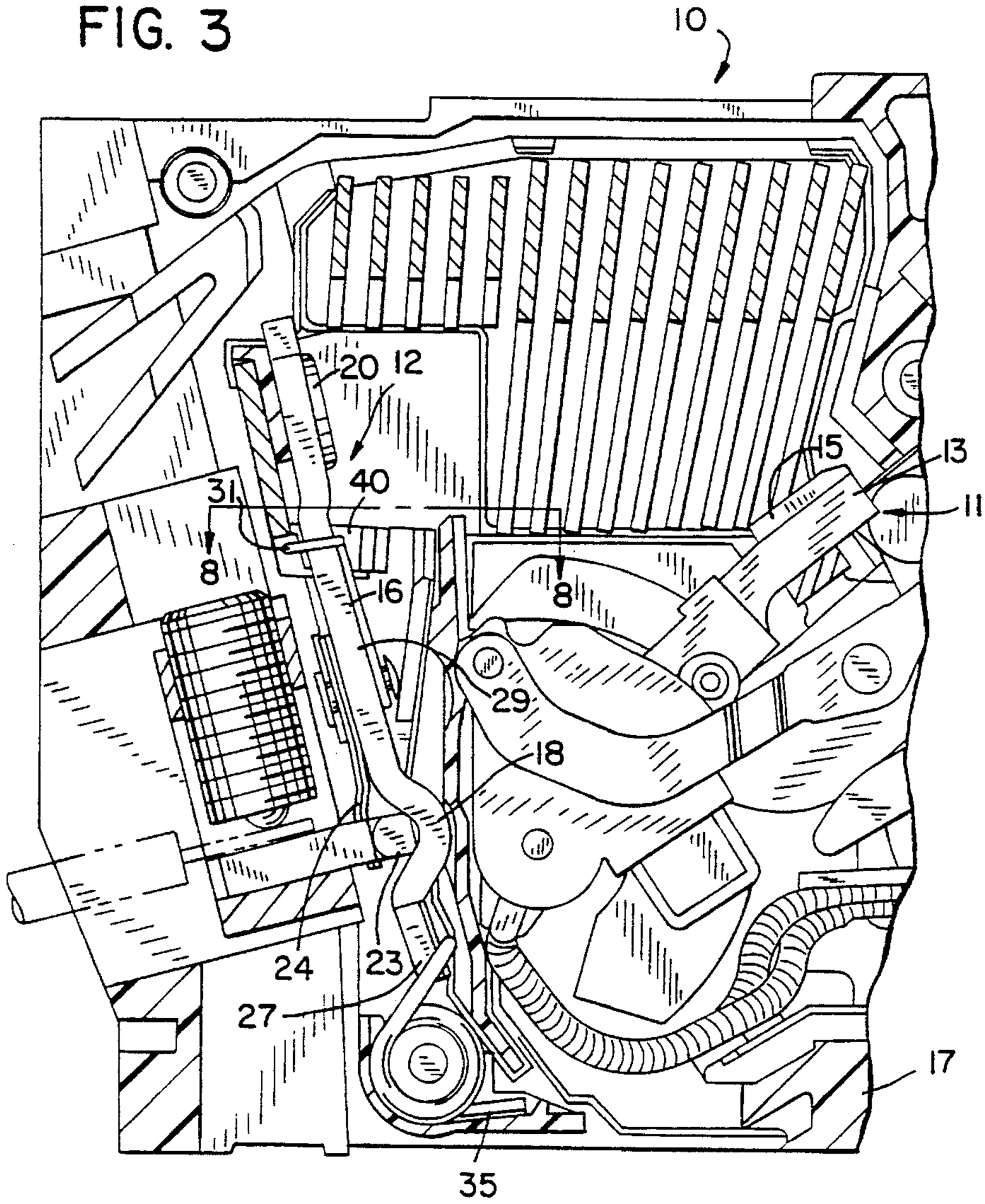


FIG. 7

FIG. 3



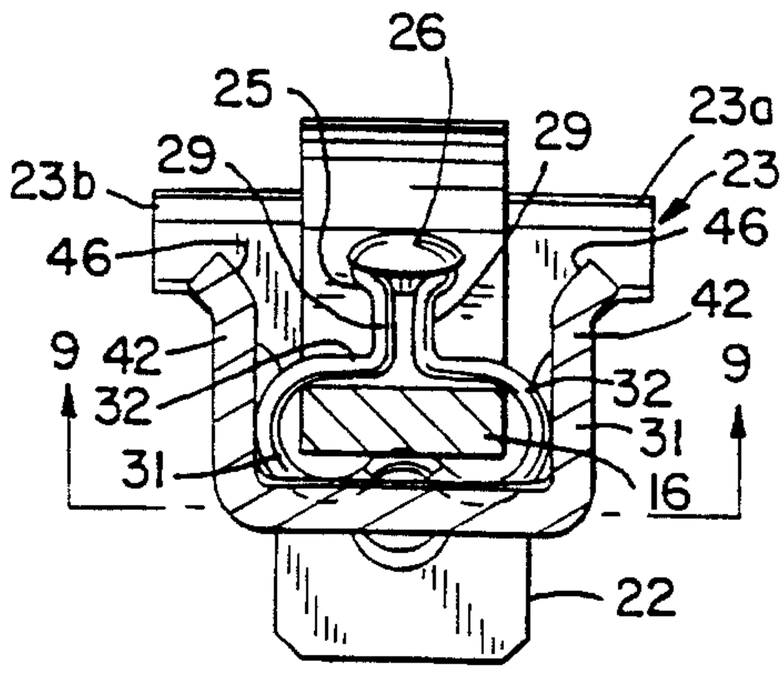


FIG. 8

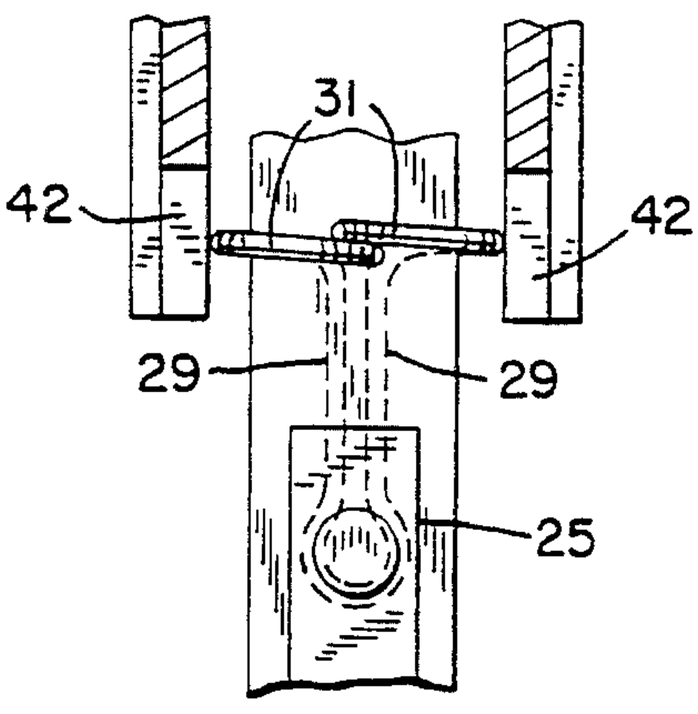


FIG. 9

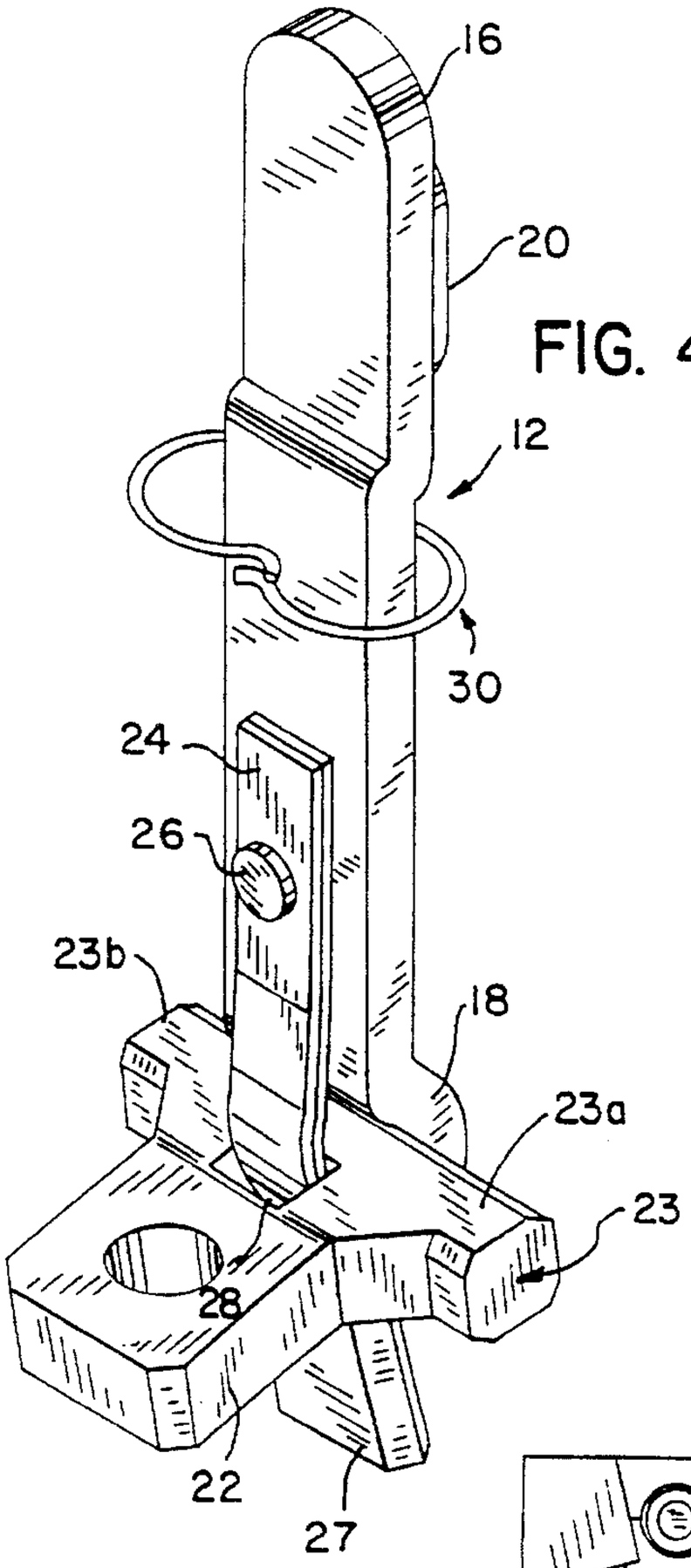


FIG. 4

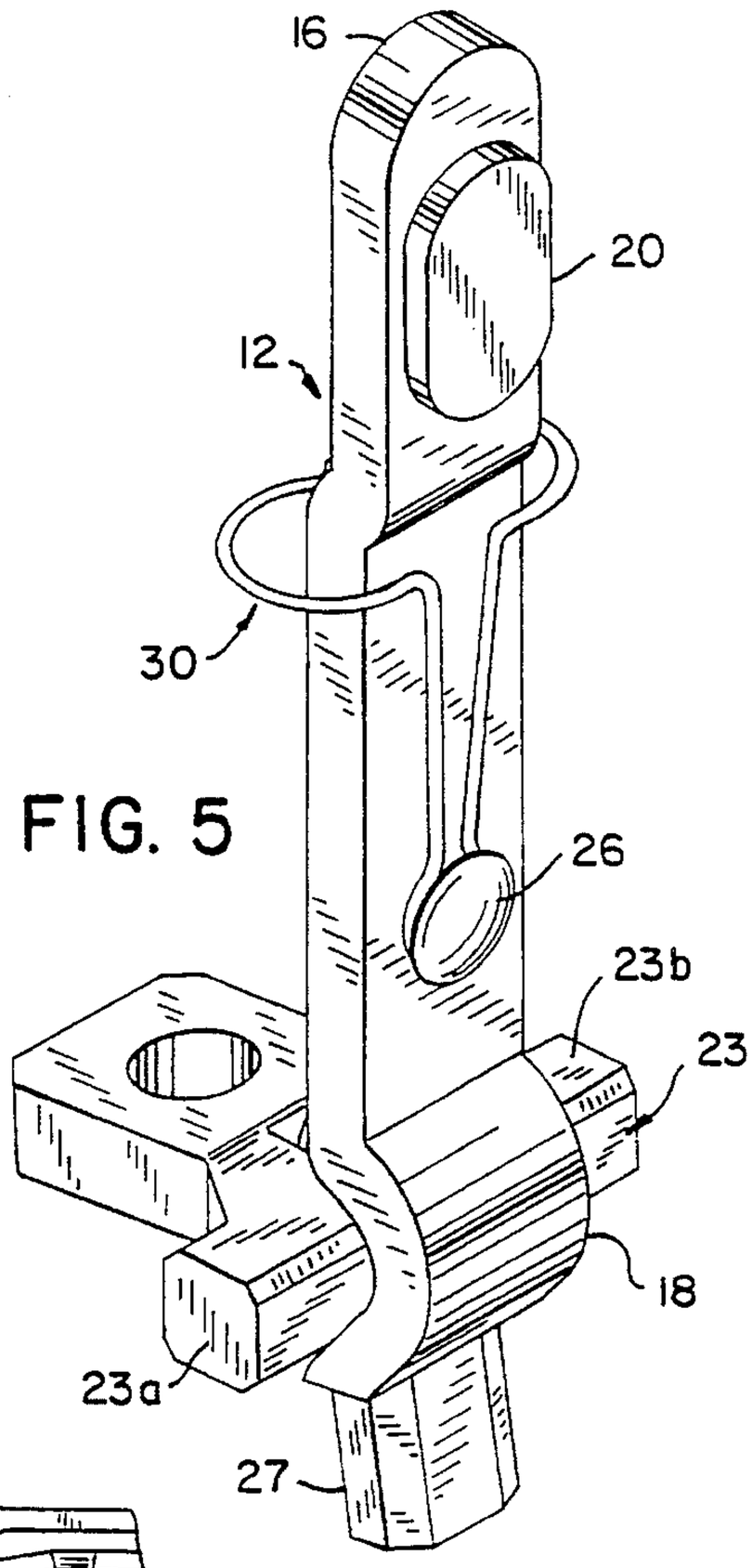


FIG. 5

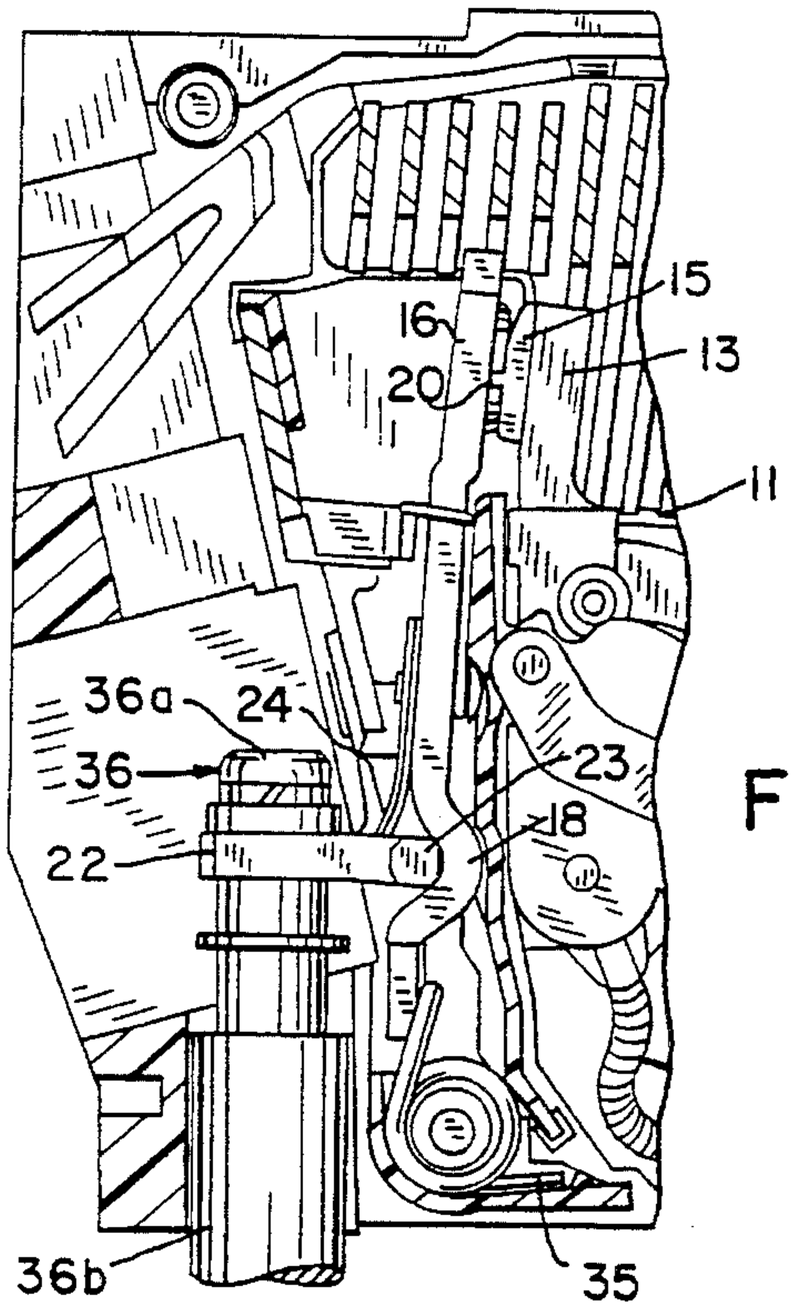


FIG. 10

PIVOTING CIRCUIT BREAKER LOAD TERMINAL

RELATED APPLICATIONS

This application is a continuation of patent application Ser. No. 08/314,467 filed on Sep. 28, 1994, entitled a Circuit Breaker With Moveable Main Contact Multi-Force-Level Biasing Element.

FIELD OF THE INVENTION

The present invention relates generally to the load terminal(s) of a circuit breaker. In particular, the present invention relates to a pivoting load terminal which can be pivoted to engage a cable extending from the back of the circuit breaker or from one side of the circuit breaker.

BACKGROUND OF THE INVENTION

Typical circuit breakers include load and line terminals which provide electrical connections between the load and line conductors and the circuit breaker. These terminals have a fixed position or configuration depending upon the application for the circuit breaker. More specifically, the terminals can have a number of positions or configurations depending upon whether the conductors connected to the circuit breaker are connected at the side or back of the circuit breaker. However, these positions and configurations are established when the circuit breaker is manufactured, and are not readily modified when the circuit breaker is used in the field. Additionally, regardless of the position or configuration of the terminals, these terminals are rigidly positioned in the circuit breaker and, in use, can not be repositioned to accommodate conductors which are oriented such that they are difficult to connect to the terminal (e.g. a 00 gauge conductor which is skewed and must be deflected with substantial force to be properly connected to the lug associated with the terminal). By way of example, see U.S. Pat. No. 5,361,051 issued on Nov. 1, 1994 to Bernard Di Marco.

In addition to the problem of connecting poorly oriented conductors to the terminals of a circuit breaker, there is a need to reduce the size of circuit breakers for a given current interrupting rating. Accordingly, circuit breakers have been designed with moving load contacts which increase the speed and distance between the line and load contacts when separating in response to a short circuit condition. An example of such a circuit breaker is disclosed in U.S. Pat. No. 4,594,567, issued on Jun. 10, 1986. This type of circuit breaker is typically smaller than a circuit breaker of equal rating having a fixed load contact, but requires added components such as a load contact pivot and camming arrangement. Accordingly, elimination or reduction in size of any of these added components would further reduce the size of the circuit breaker.

In view of the circuit breaker configurations discussed above, it would be desirable to provide an improved terminal configuration to improve the ability to connect a conductor to the circuit breaker. Additionally, it would be desirable to provide a terminal configuration which reduces the size of a circuit breaker for a given rating.

SUMMARY OF THE INVENTION

The present invention provides an electric switch including an enclosure, a first contact moveable between first and second positions within the enclosure, and an operating mechanism supported by the enclosure and coupled to the first contact to move the first contact between positions. The switch also includes a terminal supported by the enclosure and exposed to the exterior of the enclosure, and a second contact arm including a second contact, and pivotally and electrically connected to the terminal at the interior of the enclosure. The contact arms are arranged so the first contact engages the second contact when the first contact is in the first position.

The present invention further provides a circuit breaker including a base including a top side and a bottom side, a first contact arm including a first contact moveable between first and second positions, and an operating mechanism supported by the top side of the base and coupled to the first contact arm to move the first contact arm between positions. The circuit breaker also includes a terminal pivotally connected to the top side of the base, and a second contact arm including a second contact and pivotally connected to the terminal. The contact arms are supported so that first contact engages the second contact when the first contact arm is in the first position.

Another configuration of the circuit breaker includes three phases. This multi-phase circuit breaker includes a base, at least three line contact arms each including a line contact and moveable between first and second positions, and an operating mechanism supported by the base and coupled to the line contact arms to move the line contact arms between positions. The circuit breaker also includes at least three load terminals pivotally connected to the base, and at least three load contact arms each including a load contact. Each of the load contact arms being pivotally connected to one of the respective load terminals, where the first contacts engage the second contacts when the first contact arms are in the first position.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side elevation view, partly broken away, of the molded case circuit breaker according to the present invention with the contact blades shown in the closed position;

FIG. **2** is a partial view of FIG. **1** showing the contact blades in the open position;

FIG. **3** is a view similar to FIG. **2** showing the contact blades in the blown open position;

FIG. **4** is a perspective view of the load contact blade assembly;

FIG. **5** is a perspective view of the load contact blade assembly;

FIG. **6** is a view taken on line **6—6** of FIG. **2** showing the contact pressure spring assembly;

FIG. **7** is a view taken on line **7—7** of FIG. **6**;

FIG. **8** is a view taken on line **8—8** of FIG. **3**;

FIG. **9** is a view taken on line **9—9** of FIG. **8**; and

FIG. **10** is a view of an alternate terminal connection arrangement.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. **1**, a circuit breaker **10** includes an enclosure having a base **17**, a line contact blade assembly **11**, a load contact blade assembly **12**, an arc chamber **19** supported by the enclosure above the contact blade assemblies **11** and **12** and a contact operating mechanism **14**. The blade assemblies **11** and **12** are pivotally supported by base **17**. The line contact blade assembly **11** is shown in the

closed position in FIG. **1**, and in the open position in FIG. **2**. Assemblies **11** and **12** are shown in the blown open position in FIG. **3**. Line contact blade assembly **11** generally includes a blade **13** having an electrical contact **15** on the upper end. Blade **13** is pivotally supported by base **17**.

Operating mechanism **14** is supported by base **17** and provided for moving blade assembly **11** between open and closed positions with respect to load contact blade assembly **12**. Depending upon the application (i.e. single or multi-pole), operating mechanism **14** will interact with a crossbar to move multiple assemblies **11** simultaneously. The present embodiment of circuit breaker **10** includes three poles. However, for purposes of clarity, only a single pole of circuit breaker **10** is described herein. By way of example, operating mechanism **14** can be configured as shown and described in U.S. Pat. No. 4,594,567 noted above.

Load contact blade assembly **12** generally includes a blade **16** having V-shaped offset bearing section **18** at the lower end and an electrical contact **20** at the upper end which is positioned to engage electrical contact **15** on line contact blade **13**. A terminal strap **22** having a multi-sided (e.g., octagonal) cross piece or shaft **23** which is seated in bearing section **18** and retained therein by a leaf spring **24** which is secured to the blade **16** by a rivet **26**. Alternatively, shaft **23** could have a circular cross-section. The lower end of the spring **24** projects into an opening **28** in the terminal strap **22**. Strap **22** is pivotally supported at the end bearing portions **23***a* and **23***b* of piece **23** by an appropriate bearing structure in base **17** (e.g. molded recess). For example, portions **23***a* and **23***b* could be captured between base **17** and the top portion of the circuit breaker **10** enclosure when base **17** and the top portion are joined. Thus, strap **22** can pivot about the axis of shaft **23** relative to base **17**.

A feature of this arrangement is the dual function of terminal strap **22** which allows load contact blade **16** to pivot or rotate generally about the axis of cross piece **23** and allows terminal strap **22** to rotate into a plurality of positions relative to base **17**. With this arrangement the terminal strap **22** can be pivoted to engage a clamp-type line connector **34**, as shown in FIG. **1**, or pivoted to engage a threaded line connector **36**, as shown in FIG. **10**. Connector **36** includes a threaded fastener **36***a* which passes through an opening in terminal **22** and engages the threads of a threaded wire end **36***b*. The conductor is attached to terminal **22** so the axis of the end portion of the conductor is substantially coincident with the axis of fastener **36***a*.

Load contact blade assembly **12** is pivoted about piece **23** and biased into engagement with the line contact blade assembly **11** by a return spring **35** in the form of a torsion spring which is mounted on base **17** in a position to engage lower end **27** of load contact blade **16**.

The dual position of terminal **22** allows an increased arc chamber design, for improved operation of the circuit breaker under short circuit conditions, without extending the length of the overall circuit breaker. The angular position of terminal **22** as shown in FIG. **1** allows access to the wire clamping screw of connector **34** from the front of circuit breaker **10**, while the position of terminal **22** as seen in FIG. **10** allows connection from the rear of circuit breaker **10**.

Another advantage of the present configuration is the provision of V-shaped offset bearing section **18** of load contact blade **16** which makes contact with the cross piece **23** of terminal strap **22**. The crosspiece **23** is seated against the angled sides of the V-shaped bearing section **18**. This configuration increases the contact forces between the blade **16** and the strap **22**. The contact forces with the V-shaped bearing are greater than they would be with, for example, a circular-shaped journal bearing. It is advantageous to increase these contact forces for two reasons. First, because electrical current is conducted through this bearing, the increased contact forces tend to reduce the resistance to electrical current flow through the bearing surfaces. Accordingly, by reducing electrical resistance, this also reduces the amount of heat produced in the bearing. Second, it is important to have sufficiently high contact forces in order to counteract the effects of current constriction forces in the bearing interface. Typically, when two electrical conductors make physical contact with each other, and an electrical current flows from one conductor into the other through the contact interface, an electrodynamic repulsion force, due to the phenomenon of current constriction, arises between the two parts which tends to separate them. In the bearing surface between the load contact blade **16** and the terminal strap **22**, such separation would be undesirable because it would result in an electric arc which would damage the bearing surfaces. The increased contact forces of the present configuration help to prevent separation from occurring.

A contact pressure wire spring **30** is mounted on the front of the load contact blade **12** by rivet **26** for leaf spring **24**. Spring **30** as shown in FIGS. **6** and **7** includes a semi-circular loop **25** fixed to blade **16** by rivet **26**. A pair of legs (i.e., beam spring portions) **29** are provided on the ends of loop **25** which diverge outwardly. A second semi-circular loop **31** is formed at the upper end of each of the legs **27**. Loops **31** are bent at a right angle to the upper end of each leg **29**. Loops **31** are biased outwardly by diverging legs **29** on loop **25**.

A U-shaped channel member **40** is formed from a single piece of sheet steel or other ferrous material and includes a pair of side walls **42** extending outwardly from a base **44**. A pair of opposed spring cam surface are provided by a surface **46** on the outer edges of each of side walls **42** extending at a predetermined angle (e.g. 25–65 degrees) from the parallel portion **46***a* of member **40**. U-shaped member **40** is magnetically attracted to the loops **31** and blade **16** due to the magnetic field produced by the current in blade **16**. This attraction delays the release of blade **16** and loops **31** from U-shaped channel member **40** until the arc between contacts **15** and **20** is extinguished. When the arc is extinguished and the blow apart forces subside, the return spring **35** will bias load contact blade assembly **12** to its original position.

In operation, loops **31** are initially in direct engagement with cam surfaces **46** when the load contact blade assembly **12** is in the closed position. The wire form spring **30**, in combination with the return spring **35**, and the interaction of piece **23**, section **18** and leaf spring **24**, holds the electric contact **20** on the load contact blade **16** in engagement with the electric contact **15** on the line contact blade **13** with an appropriate force. When the electromagnetic forces (i.e., blow apart) caused by the substantially parallel and opposite currents in blades **13** and **16** exceed a predetermined limit (i.e., during short circuit conditions), loops **31** slide along cam surfaces **46**, are compressed and move to engage side walls **42** of U-shaped member **40**. Upon engaging walls **42**, the force loops **31** produce to restrict movement of blade **16** (i.e., counter-clockwise rotation) are greatly reduced to facilitate contact blow apart.

Although the invention has been described in conjunction with specific embodiments thereof, it is evident that alternatives, modifications and variations will be apparent to those skilled in the art. For example, the position of springs **30** and U-shaped channel member **40** could be reversed so that member **40** is fastened to arm **16** and spring **30** is fixed

relative to base **17**. It is intended that the claims embrace all such alternatives, modifications and variations that fall within the spirit and broad scope of the appended claims.

What is claimed is:

1. An electric switch comprising:

an enclosure;

a first contact moveable between first and second positions within the enclosure;

an operating mechanism supported by the enclosure and coupled to the first contact to move the first contact between positions;

a terminal pivotally supported by the enclosure and exposed to the exterior of the enclosure; and

a second contact arm including a second contact, and pivotally and electrically connected to the terminal at the interior of the enclosure, the first contact engaging the second contact when the first contact is in the first position.

2. The switch of claim **1**, wherein the terminal includes a shaft pivotally attached to the enclosure.

3. The switch of claim **2**, wherein the second contact arm includes a bearing portion pivotally attached to the shaft.

4. The switch of claim **3**, wherein the bearing portion includes a bearing offset section in contact with the shaft and a spring member attached to the second contact arm and in contact with the shaft.

5. The switch of claim **3** further comprising a line connector clamp mechanically attached to the terminal.

6. The switch of claim **3**, wherein the terminal includes an opening accessible from the exterior of the circuit breaker, and the circuit breaker further comprises a threaded wire end fastened to the terminal by a threaded fastener passing through the opening, the wire end being electrically connectable to an end portion of a conductor such that the longitudinal axis of the end portion of the conductor is parallel with the axis of the threaded fastener.

7. A circuit breaker comprising:

a base including a top side and a bottom side;

a first contact arm including a first contact and moveable between first and second positions;

an operating mechanism supported by the base and coupled to the first contact arm to move the first contact arm between positions;

a terminal pivotally connected to the base; and

a second contact arm including a second contact arm pivotally connected to the terminal, the first contact engaging the second contact when the first contact arm is in the first position.

8. The circuit breaker of claim **7**, wherein the terminal includes a shaft pivotally attached to the base.

9. The circuit breaker of claim **8**, wherein the second contact arm includes a bearing portion pivotally attached to the shaft.

10. The circuit breaker of claim **9**, wherein the bearing portion includes an arcuate offset section in contact with the shaft and a spring member attached to the second contact arm and in contact with the shaft.

11. The circuit breaker of claim **10**, wherein the terminal includes an exterior portion accessible from the exterior of the circuit breaker.

12. The circuit breaker of claim **11** further comprising a line connector clamp mechanically attached to the exterior portion.

13. The circuit breaker of claim **11**, wherein the exterior portion includes an opening, and the circuit breaker further comprises a threaded wire end fastened to the terminal by a threaded fastener passing through the opening, the wire end being electrically connectable to an end portion of a conductor such that the longitudinal axis of the end portion of the conductor is parallel with the axis of the threaded fastener and extends outwardly from the bottom side of the base.

14. A multi-phase circuit breaker comprising:

a base;

at least three line contact arms each including a line contact and moveable between first and second positions;

an operating mechanism supported by the base and coupled to the line contact arms to move the line contact arms between positions;

at least three load terminals pivotally connected to the base; and

at least three load contact arms each including a load contact, each of the load contact arms being pivotally connected to one of the respective load terminals, the first contact engaging the second contact when the first contact arm is in the first position.

15. The circuit breaker of claim **14**, wherein the terminals each include a shaft pivotally attached to the base.

16. The circuit breaker of claim **15**, wherein the second contact arms each include a bearing portion pivotally attached to one of the respective shafts.

17. The circuit breaker of claim **16**, wherein the bearing portions each include an offset section in contact with the respective shaft, and a spring member attached to the respective second contact arm and in contact with the respective shaft.

18. The circuit breaker of claim **17**, wherein the terminals each include an exterior portion accessible from the exterior of the circuit breaker.

19. The circuit breaker of claim **18** further comprising one line connector clamp mechanically attached to each exterior portion.

20. The circuit breaker of claim **19**, wherein the exterior portion includes an opening, and the circuit breaker further comprises one threaded wire end fastened to each exterior portion by a threaded fastener passing through the opening, each wire end being electrically connectable to an end portion of a conductor such that the longitudinal axis of the end portion of the conductor is parallel with the axis of the respective threaded fastener and extends outwardly from the bottom side of the base.

* * * * *